EXHIBIT K

MAAP-011248-DIE

Power Amplifier, 1 W
DC - 22 GHz
Rev. V4

Features

- High Gain: 14 dB @ 12 V
- P1dB: 28 dBm @ 12 V
- P3dB: 30.5 dBm @ 12 V
- Output IP3: +38 dBm @ 12 V
- Supply Voltage: V_{DD} = 9 - 12 V
- Supply Current: I_{DSQ} = 400 mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- Die Size: 2.99 x 1.5 x 0.1 mm
- RoHS* Compliant

Description

The MAAP-011248-DIE is a 1 W distributed power amplifier offered as a bare die part. Operating from DC to 22 GHz, this power amplifier provides 14 dB of linear gain and 30.5 dBm of output power at 3-dB compression. The device is fully matched across the band and includes a temperature compensated output power detector.

The MAAP-011248-DIE can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for test and measurement, EW, ECM, and radar applications.

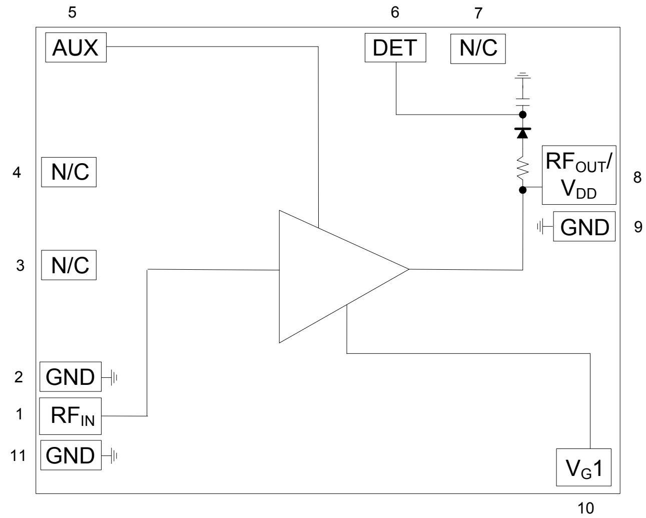
This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

Ordering Information

Part Number	Package
MAAP-011248-DIE	Gel Pack[1]

1. Die quantity varies.

Functional Schematic



Pin Configuration[2]

Pin No.	Pin Name	Description
1	RF_{IN}	RF Input
2	GND	Ground
3, 4	N/C	No Connection
5	AUX	Auxiliary
6	DET	Power Detector
7	N/C	No Connection
8	RF_{OUT}/V_{DD}	RF Output / Drain Voltage
9	GND	Ground
10	V_{G1}	Gate Voltage
11	GND	Ground

2. Backside of die must be connected to RF, DC and thermal ground.

*Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

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Electrical Specifications: T_A = +25°C, V_{DD} = 12 V, I_{DSQ}[3] = 400 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 12 GHz 18 GHz 22 GHz	dB	— 11.5 — 11.5	13.0 13.5 14.0 14.5	—
P_{OUT}	P_{IN} = +20 dBm 2 GHz 12 GHz 18 GHz 22 GHz	dBm	— 29.5 — 29.0	32.0 30.9 30.5 30.5	—
P1dB	2 GHz 12 GHz 18 GHz 22 GHz	dBm	—	30.5 29.0 28.0 27.5	—
OIP3	P_{OUT} = +14 dBm/tone (10 MHz Tone Spacing) 2 GHz 12 GHz 18 GHz 22 GHz	dBm	—	41.0 38.0 38.0 41.0	—
PAE	P_{IN} = +20 dBm 2 GHz 12 GHz 18 GHz 22 GHz	%	—	20.0 18.0 17.5 13.4	—
Input Return Loss	P_{IN} = -20 dBm	dB	—	15	—
Output Return Loss	P_{IN} = -20 dBm	dB	—	15	—
I_{DD} (with RF drive)	P_{IN} = +20 dBm	mA	—	500	—
I_{G1}	—	mA	—	8	—

3. Set I_{DSQ} according to bias procedures in page 4.

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Electrical Specifications: T_A = +25°C, V_{DD} = 10 V, I_{DSQ}[3] = 400 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 12 GHz 18 GHz 22 GHz	dB	—	13.0 13.5 14.0 14.5	—
P_{OUT}	P_{IN} = +18 dBm 2 GHz 12 GHz 18 GHz 22 GHz	dBm	—	29.0 29.0 29.0 28.0	—
P1dB	2 GHz 12 GHz 18 GHz 22 GHz	dBm	—	28.0 28.0 26.5 25.5	—
OIP3	P_{OUT} = +14 dBm/tone (10 MHz Tone Spacing) 2 GHz 12 GHz 18 GHz 22 GHz	dBm	—	45.0 41.5 47.0 40.0	—
PAE	P_{IN} = +18 dBm 2 GHz 12 GHz 18 GHz 22 GHz	%	—	18.5 17.0 16.0 12.5	—
Input Return Loss	P_{IN} = -20 dBm	dB	—	15	—
Output Return Loss	P_{IN} = -20 dBm	dB	—	15	—
I_{DD} (with RF drive)	P_{IN} = +18 dBm	mA	—	450	—
I_{G1}	—	mA	—	8	—

Maximum Operating Ratings

Parameter	Rating
Input Power	20 dBm (V_{DD} = 12 V) 18 dBm (V_{DD} = 10 V)
Junction Temperature[4,5]	+150°C
Operating Temperature	-40°C to +85°C

4. Operating at nominal conditions with junction temperature ≤ +150°C will ensure MTTF > 1×10^6 hours.
5. Junction Temperature (T_J) = T_C + Θ_{JC} * ((V * I) - (P_{OUT} - P_{IN}))
   Typical thermal resistance (Θ_{JC}) = 6.5°C/W.
   a) For T_C = +85°C,
   T_J = +117°C @ 12 V, 0.48 A, P_{OUT} = 30 dBm, P_{IN} = 20 dBm

Absolute Maximum Ratings[6,7]

Parameter	Absolute Maximum
Input Power	28 dBm
Drain Voltage	+16 V
Gate Voltage	-5 to 0 V
Junction Temperature[8]	+175°C
Storage Temperature	-65°C to +125°C

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

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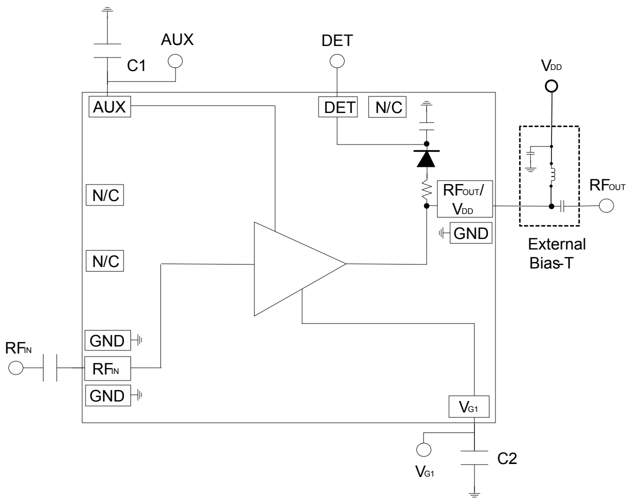
Application Schematic



Bill of Materials[9,10,11]

Part	Value	Size	Comment
C1, C2	1 µF	0402	bypass

9. C1 & C2 are required for operation below 1 GHz.
10. High power external bias tee was used for measurements.
11. External DC block was used on input.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

Recommended PCB Information

RF input and output are 50 Ω transmission lines.
Single layer 4 mil Rogers RO4350B with 1/2 oz. Cu.
Use copper filled vias under ground paddle.

Grounding

It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200-µm) diameter vias under the device, assuming an 8-mil (200-µm) thick RF layer to ground.

Biasing Conditions

Recommended biasing conditions are V_{DD} = 12 V, I_{DSQ} = 400 mA (controlled with V_{G1}).

V_{DD} Bias must be applied through a resonant free high inductance on the RF output line.

By-pass capacitor C1 for the auxiliary pad is for a low frequency operation extension (below 1 GHz).

Operating the MAAP-011248

Turn-on

1. Apply V_{G1} (-4.5 V).
2. Increase V_{DD} to 12 V.
3. Set I_{DSQ} by adjusting V_{G1} more positive (typically -3.6 V for I_{DSQ} = 400 mA).
4. Apply RF_{IN} signal.

Turn-off

1. Remove RF_{IN} signal.
2. Decrease V_{G1} to -4.5 V.
3. Decrease V_{DD} to 0 V.

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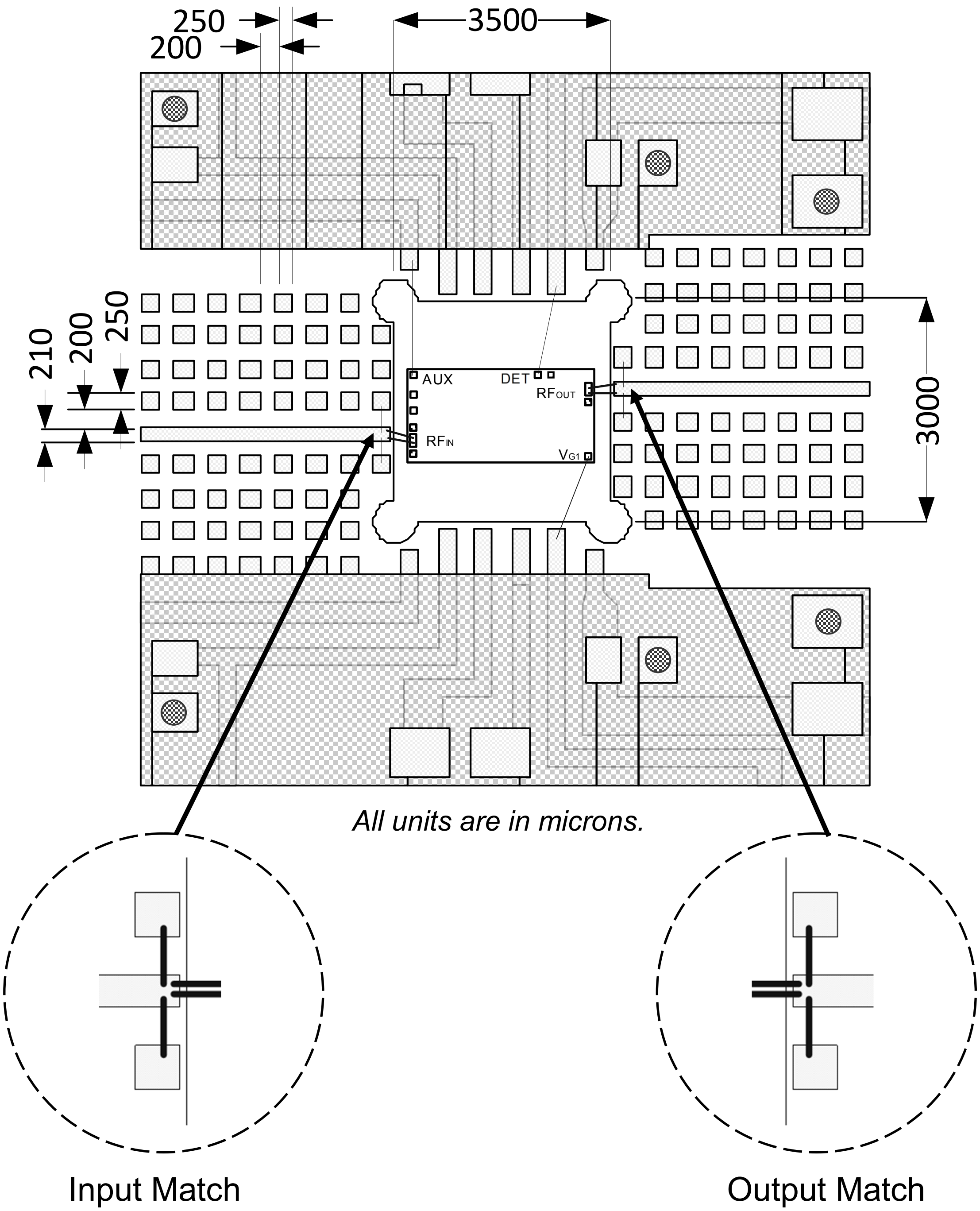
PCB Layout:

RF input and output port pre-matching circuit patterns are designed to compensate bonding wires. Input and output matching are identical.



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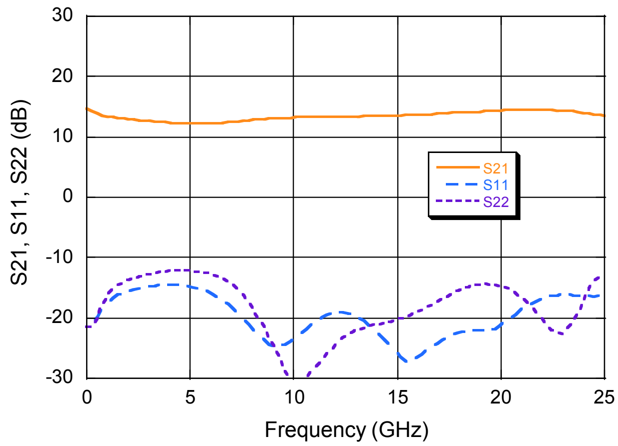
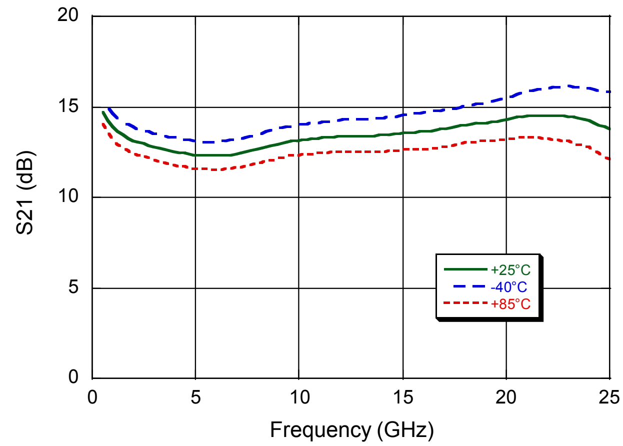
Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 400 mA, V_{G1} = -3.6 V typical

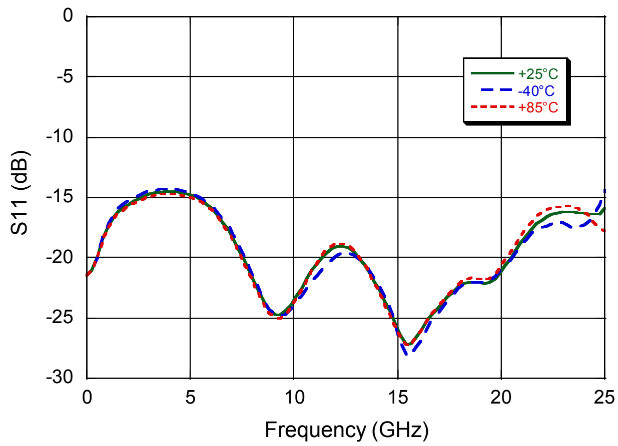
S Parameters



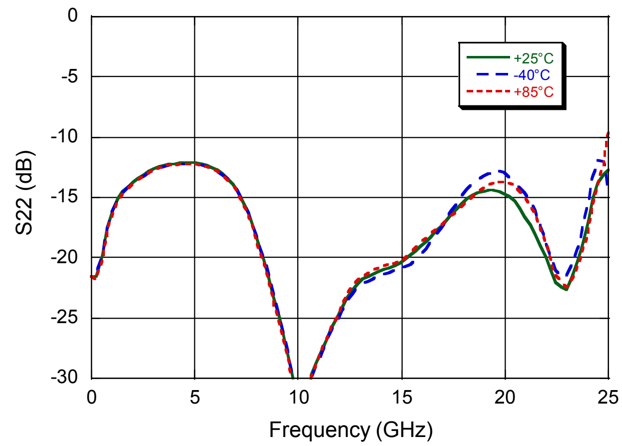
Gain



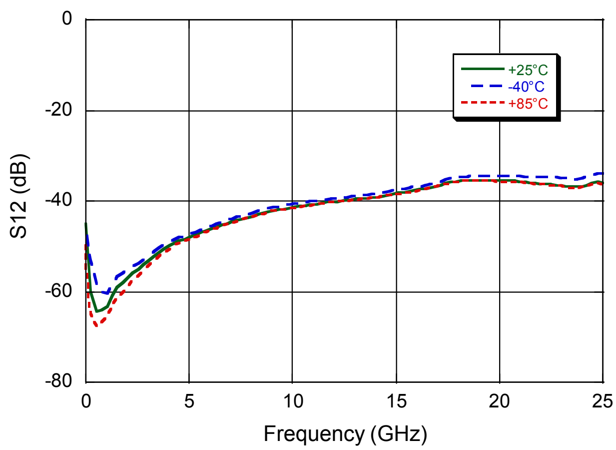
Input Return Loss



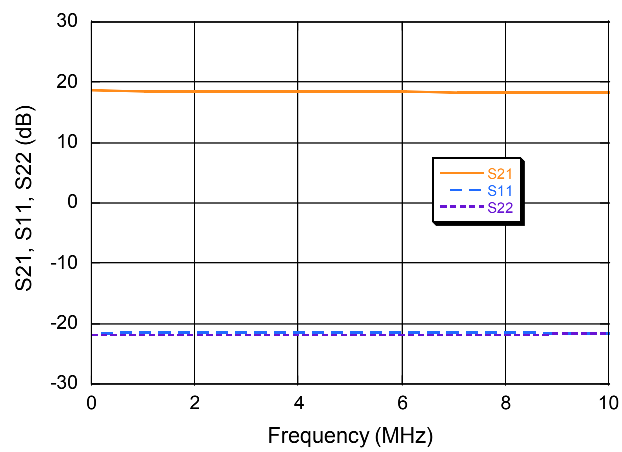
Output Return Loss



Isolation



S Parameters @ Low Frequency



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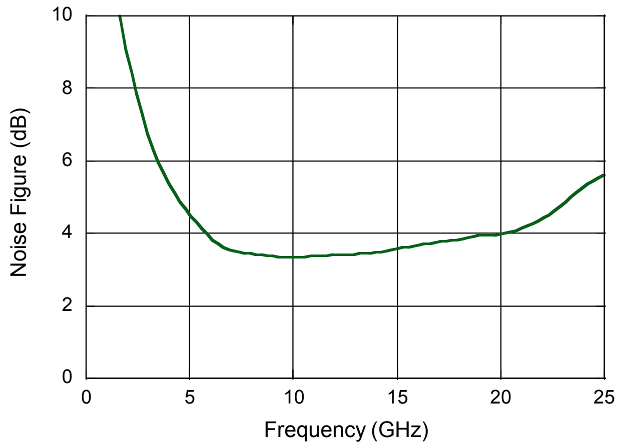
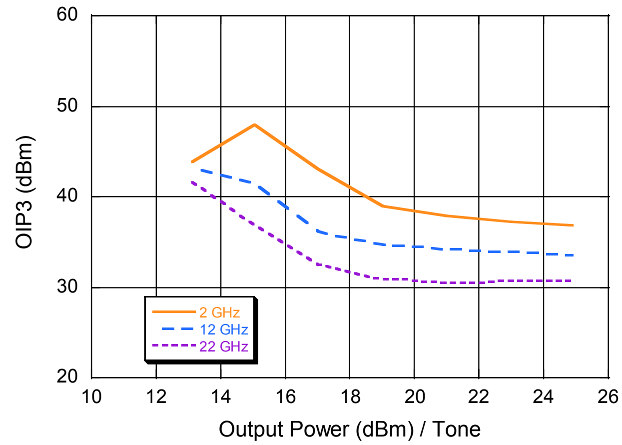
Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 400 mA, V_{G1} = -3.6 V typical

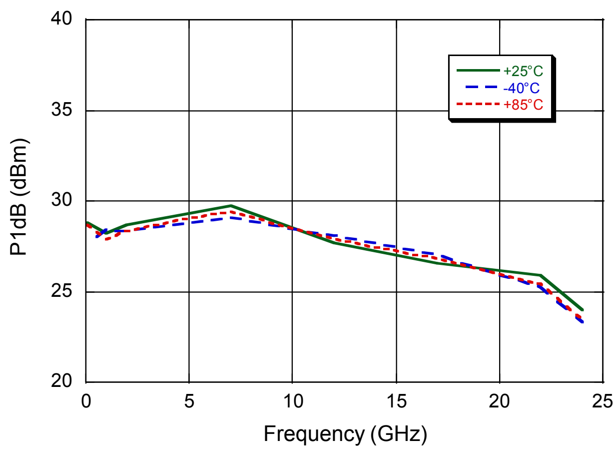
Noise Figure



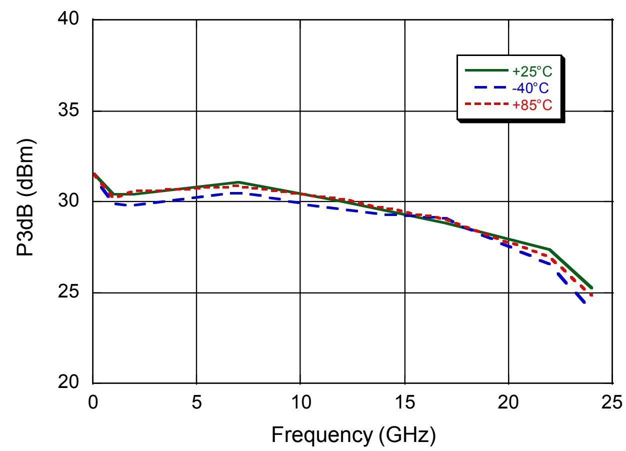
Output IP3 vs. P_{OUT} / Tone



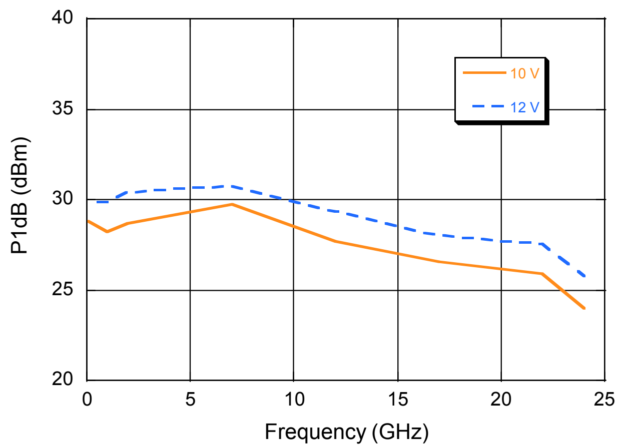
P1dB over Temperature



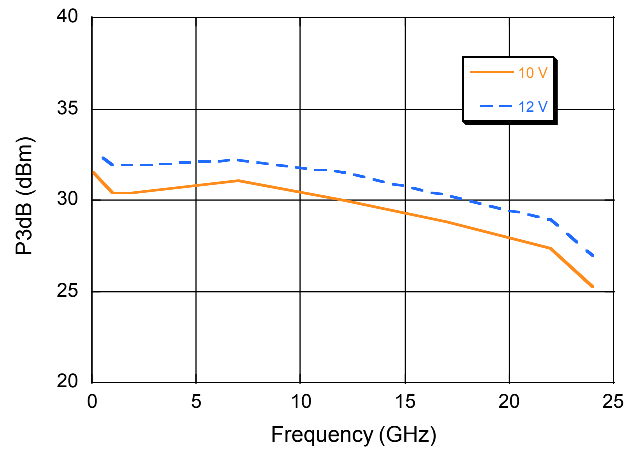
P3dB over Temperature



P1dB over Voltage



P3dB over Voltage



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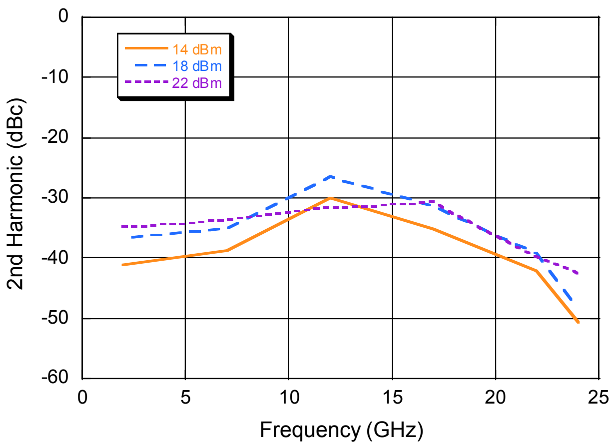
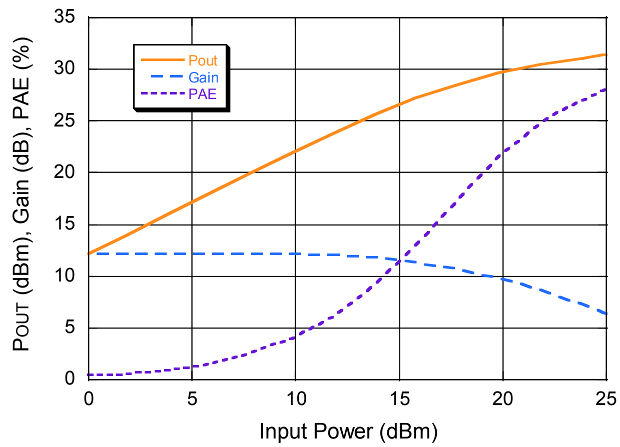
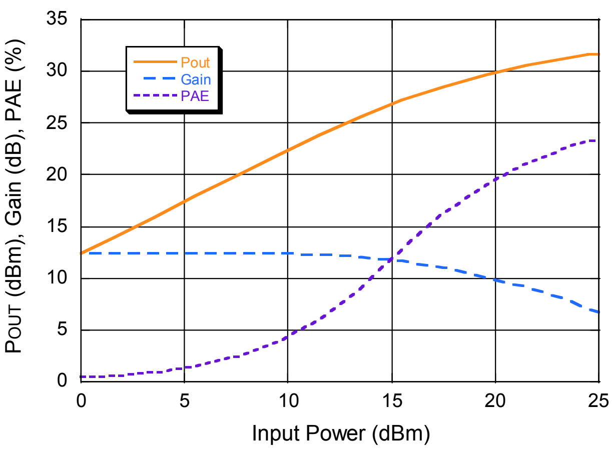
2nd Harmonic



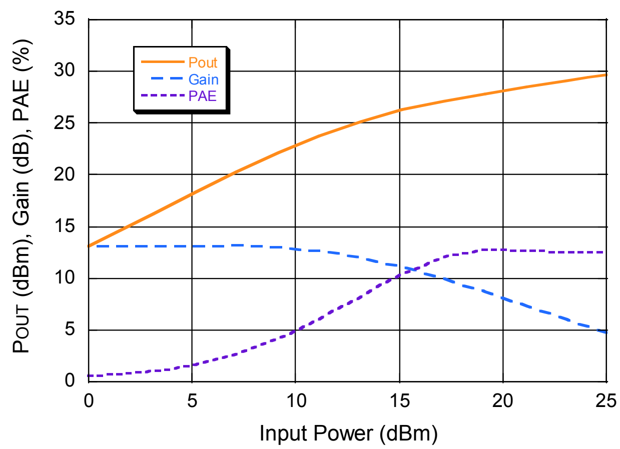
Power Compression @ 2 GHz



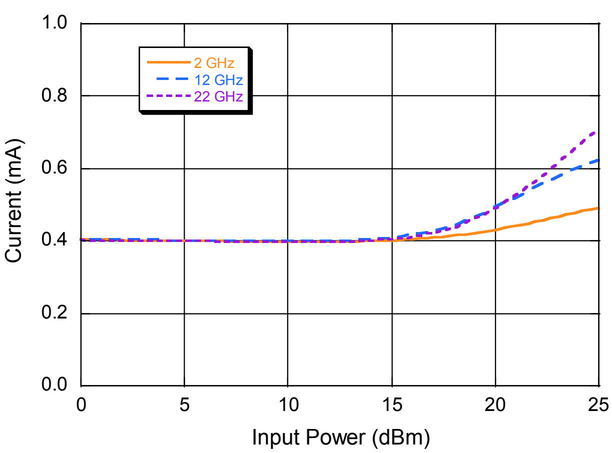
Power Compression @ 12 GHz



Power Compression @ 22 GHz



Current



For further information and support please visit:
https://www.macom.com/support

DC-0011199

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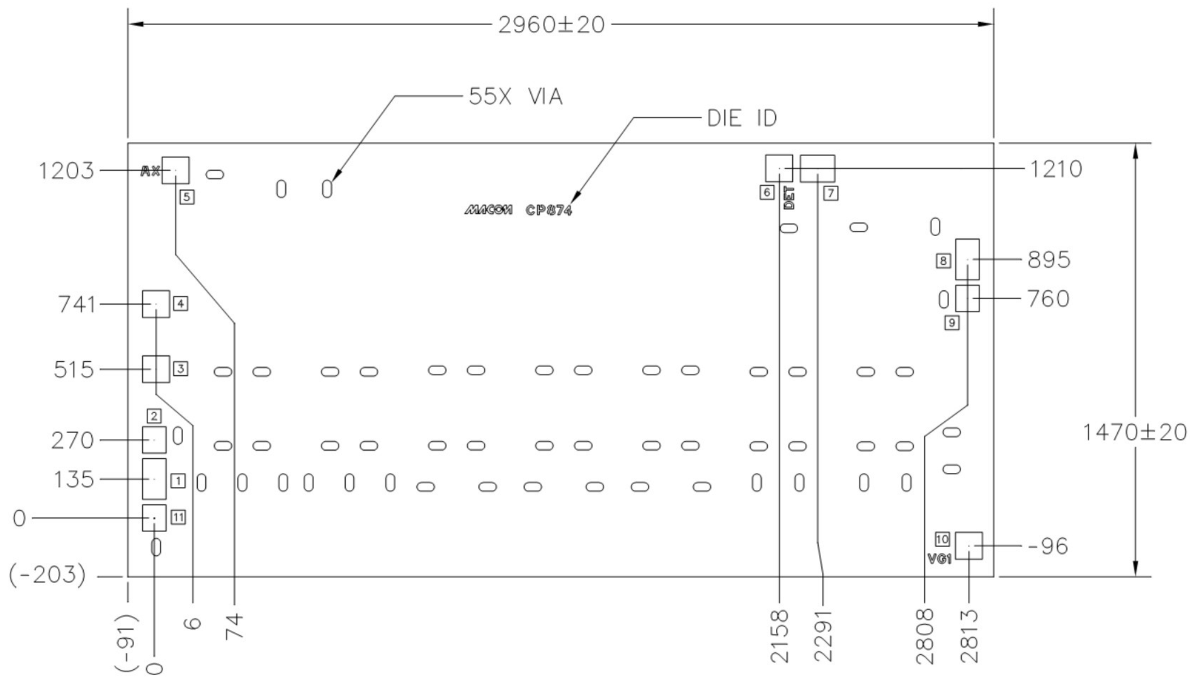
MMIC Die Outline[12,13]



12. All units in µm, unless otherwise noted, with a tolerance of ±5 µm.
13. Die thickness is 100 ±10 µm.

Bond Pad Detail

Pad	Size (x) (µm)	Size (y) (µm)
1, 8	81	141
2, 9, 11	81	91
3, 4, 5, 6, 10	93	93
7	118	93

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